MP MASTER
MA33516

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WATLOW GORDON

XacTcal 1
Instruction Manual

Part # 51900101

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how to use this manual

This manual contains all the information required to operate your new indicator/calibrator.

Before you use the instrument, we recommend you read this manual completely and review all the features and capabilities of the instrument. The manual is designed to make the use of the instrument as easy as possible. Simply refer to the table of contents (above) and on the preceding page to locate the directions for any operation you require.

introduction

about the instrument

The instrument is a multiple function indicator/calibrator that represents a major advance in hand-held industrial instrumentation. For the first time, you can easily take a laboratory grade instrument into your plant for precise measurement of temperature, millivolts and ohms and calibration of other instruments. The indicator/calibrator's light weight and battery operation permit convenient use anywhere -- in your laboratory, plant or on a job site.

The instrument permits you to input or output direct temperature readings of:
- J, K, T, E, N, W5/W26, Platinel II, R, S & B thermocouples
- 2, 3 or 4 wire, 100 ohm @ 0°C platinum RTD's having an Alpha of 0.00385

In addition, you can use it to input or output:
- any RTD in ohms
- millivolts

Three output memories are available to let you set and select any temperature, millivolt or resistance value directly, through the numeric keypad.

With the ramping feature, you can select the ramp step increment and ramp up or down from any value set in the output memories. This makes calibrating and checking alarm trip points, deadbands, proportional bands and other adjustments a snap.

optional accessories

Lab bench stand - While the cover is designed as a stand when the unit is used as a portable in the field, an attractive, smoke grey plexiglass stand is available for more stationary benchtop use.

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section 1 general care

1-1 unpacking

Unpack the instrument immediately upon receipt and check for shipping damage. If it was damaged in transit, please save the shipping carton and all packing material, report the damage and file a claim with the carrier.

Make sure you received everything you ordered by checking the items against the packing list before discarding the shipping container and packing material. Sometimes small accessories are packed in the same carton as the instrument. If all items are not accounted for, call us immediately.

1-2 storage

Treat the instrument as you would any precision electronic equipment. When not in use, replace the cover to protect the keypad and display, and store it in a secure, clean, dry area. Storage temperature (without batteries) should not be below -4°F or above 158°F (-20°C to 70°C). Remove the batteries if you don't plan to use the unit for a long period of time.

1-3 batteries

The instrument uses 6 disposable AA alkaline batteries. As fresh batteries were installed just before it was shipped, it is ready to use without any further preparation. In normal use, these batteries should last more than 70 hours. The battery compartment is located at the bottom of the back of the unit. Remove the cover by sliding it down in the direction of the arrow. When replacing the batteries, pay careful attention to the polarity indicated in the compartment. For best results, alkaline batteries should be used.

Avoid touching the battery contacts as this could contaminate the contacts and cause intermittent connections. We recommend you clean the contacts with rubbing alcohol or freon each time you replace the batteries.

1-4 AC adapter

115 V and 230 V AC adapters are available. The adapter ordered with your indicator/calibrator is included with the instrument. To use the unit with the adapter, turn it off, plug the adapter into an outlet and insert the other plug into the jack at the lower right side of the instrument. If you are using the 230 V AC adapter, you will have to install an appropriate plug on the power cord.

The instrument will not function if the cord is plugged into the jack without the adapter being plugged into a functional outlet. For reasons that will be discussed later, the instrument should be turned off by pressing the "On/Off" key, not by unplugging the AC adapter. Then you can remove the adapter from the outlet. For further details, refer to Section 2-3.

The use of an unauthorized AC adapter is not recommended and may void the warranty.

1-5 cover/stand

The indicator/calibrator has a cover which protects the key pad and display from damage. To use the instrument, slide the cover up and off its track and place it onto the back of the unit, with the name at the bottom of the instrument. The cover can be used as a stand by bending the lower half of the cover out at the hinge prior to sliding it on the unit.

Replace the cover to protect the keypad and display when the instrument is not in use or is being transported.

1-6 maintaining calibration

The instrument has several precision internal references. When it is calibrated, these internal references are accurately measured by one of the unit's microprocessors. The value of these references are then permanently stored in the instrument's memory.

During normal use, the instrument automatically recalibrates its own circuitry against those "known" references approximately every 15 seconds. This unique method of calibration enables it to maintain its high level of accuracy, stability and repeatability.

Since the unit is calibrated at the factory before shipment, it will give you precise, accurate results immediately. However, over time, the value of the internal references may change slightly as a natural result of aging. As this process varies from instrument to instrument, we recommend that your indicator/calibrator be tested and, if necessary, be recalibrated every six months to insure that it meets its specified accuracy.

section 2 Operation instructions

2-1 warm-up

To obtain optimum accuracy, the instrument should be allowed to warm up for approximately 15 minutes after being turned on. If it was recently subjected to a large change in temperature (e.g. if it was stored in the trunk of a car on an extremely hot or cold day and then brought inside a building), you should allow an hour at ambient temperature for temperature stabilization.

2-2 making your connections

One of the features of this new indicator/calibrators unique universal connector is that it accepts virtually any kind of input normally used on this type of instrument: wire, standard and miniature connectors, single banana plugs and 3 or 4 wire RTD's. To make your connections, loosen the grey "Plus" (+) and "Minus" (-) knobs by turning them counter-clockwise, insert the wire or plugs and turn the knobs clockwise to tighten the connection. Do not overtighten.

Please refer to Sections 2.6 and 2.7, for specific instructions on how to connect the unit to sensors or other instruments.

2-3 turning the instrument on/off

Turn the unit on by pressing the "On/Off" key. The display will indicate **WAIT!** for a few seconds while the instrument is initializing and resetting itself to its last configuration prior to being turned off.

When turned on, the instrument will always come up to the input mode.

To turn that unit off, press the "On/Off" key again. When the instrument is turned off, it stores, in its non-volatile memory, its last configuration, i.e. the sensor type, output memories, ramp step and °F/°C setting. Unit will display **wait** at this point also.

Do not turn the instrument off by unplugging the AC adapter or removing its batteries. This will not damage the instrument but will cause it to "forget" its last configuration. If the unit is accidently turned off by unplugging the AC adapter, removing the batteries or due to a power failure, the next time you turn it on, the display will indicate:

Reset!
Please Turn Off

This is a warning message informing you that the instrument has lost its configuration due to an improper procedure. Turn the unit off and on again. The instrument will default to Type J thermocouple.

NOTE If you are in the process of changing one of the "Select" key configurations (sensor type or one of the outputs or ramp step), you will not be able to turn the instrument off without first exiting the configuration mode by pressing the "Enter" key.

2-4 display messages

The instrument displays the following messages to inform you of its status:

WAIT!	The unit's microprocessor is making the calculations, comparisons and adjustments required to achieve its high accuracy.
Over range or Under range!	The input or output "temperature" is over or under the sensor range.
Sensor is open!	Either no sensor is attached to the unit or the sensor that is attached is broken.
Reset! Please Turn Off	The instrument has stopped operating temporarily because of an improper procedure. Turn the instrument off and on again, at which time it will default to a Type J thermocouple.
caution: Replace Battery	Batteries will last only about 4 more hours. This display will flash every 30 seconds.
Unit requires Calibration!	The instrument has lost its calibration constants and is no longer able to function properly. Recalibrate it in your own laboratory or return it for recalibration and/or repair.

°F/°C Indication

You can change the temperature readings from Fahrenheit to Centigrade, or vice versa, by pressing the "°F/°C" key.

Sensor type

To change the sensor type, press the "Select" key. The display will indicate

Select __

NOTE If you press the "Select" key by mistake, you can return to the previous mode by pressing the "Select" key again.

Press the "Sensor" key. The display will indicate the sensor menu:

Select: J K T E N W PL R S B mV Ω P

J, K, T, E, N, R, S, B = thermocouples
W = W_5W_{26} tungsten rhenium thermocouple
PL = Platinel II thermocouple
mV = millivolts
Ω = ohms
P = Platinum RTD (100Ω having an Alpha of 0.00385)

Note the blinking cursor. You can move this cursor to the right by pressing the Δ (up) and to the left by pressing the ∇ (down) key.

Select the sensor you wish to use and press the "Enter" key to load this sensor into the instrument's memory. After "Enter" is pressed, the unit will return to its previous mode.

NOTE If Ω or P (Platinum RTD) are selected, an additional menu will be displayed for 3 or 4 wire selections. After selecting 3 or 4 wires by pressing the up or down keys, press "Enter" to input your selection and return to the previous mode.

When the sensor type is changed, the configuration is initialized as follows.

Output 1 - is set for the bottom of the selected sensor's range
Output 2 - is set for the middle of the range
Output 3 - is set for the top of the range
Ramp Step - 100.0 degrees, 1.000 mV or 10.00 Ω, depending on the sensor selected.

Output memories

To change the output memories, press the "Select" key. The display will indicate.

Select _

NOTE If you press the "Select" key by mistake, you can return to the previous mode by pressing the "Select" key again.

Press the "Output" key for the output you wish to change (the "Output 1" key to change the contents of Output 1, the "Output 2" key to change the contents of Output 2, etc.). The display will prompt you by indicating:

Select Output # ____: (Memory Contents)

Use the numeric keypad to input new value into memory. The value can be changed from plus to minus and vice versa by pressing the "+/-" key. If you make a mistake, you can "Clear" your entry by pressing the "Input" and "Sensor" keys together and starting over again.

Press "Enter" to load the new value into the selected output's memory. After "Enter" is pressed, the instrument will return to its last mode of operation.

The new value selected will remain in the output's memory until a new value is entered on the sensor type is changed, even if the instrument is turned off.

If the display indicates **Under Range! or Over range!** when you press "Enter", the new value you tried to load is either under or over the range of your selected sensor. This message will remain on the display for about 10 seconds, after which the lowest (if **Under range!** was displayed) or the highest (if **Over range!** was displayed) temperature in your sensor's range is displayed.

NOTE While in one of the output modes, ramping up or down also changes the value of that output's memory. See Section 2-7.

Ramp step

To change the ramp step (the value by which the instrument will increment or decrement when it is in the ramp mode and the Δ (up) or ∇ (down) keys are pressed):

Press the "Select" key. The display will indicate:

Select __

NOTE If you press the "Select" key by mistake, you can return to the previous mode by pressing the "Select" key again.

Press the "Ramp" key. The display will indicate:

Select Ramp step (current ramp step)

Use the numeric keypad to input a new ramp step value into the instrument. If you make a mistake, press "Clear" keys ("Input" and "Sensor" keys, simultaneously) and start over. The greatest ramp step value is 999.9° mV or 999.99 Ω, depending on the sensor selected.

Press "Enter" to input the new value into the instrument's memory. The new ramp step value will remain in memory until you change it, or a new sensor is selected.

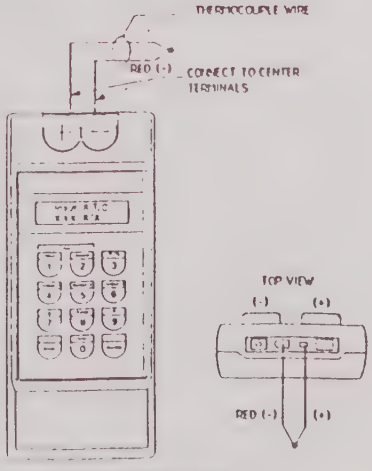
2-6 Input mode

thermocouple input

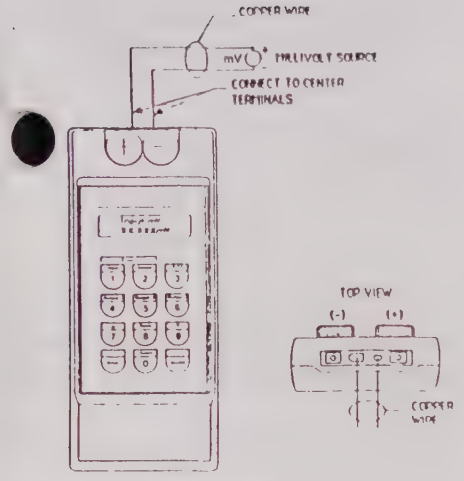
Connect your thermocouple leads to the instrument's two center terminals, observing polarity (in the U.S., the red thermocouple lead is always negative). See Figure 2.1.

NOTE Try not to touch the ends of the wire or plugs with your fingers as this will warm the cold junction or the thermocouple and cause erroneous readings until the wire returns to ambient temperature. Configure the instrument to the thermocouple type you are using. See Section 2-5.

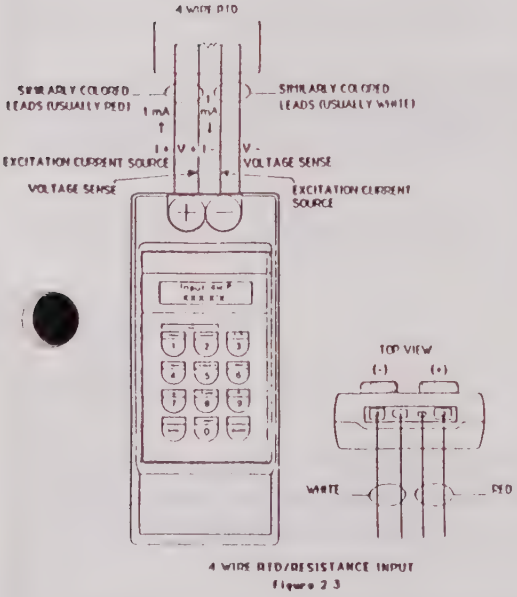
Read the temperature on the display.



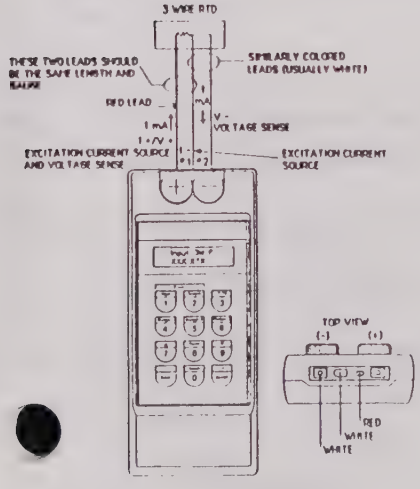
THERMOCOUPLE INPUT
Figure 2.1



MILLIVOLT INPUT
Figure 2.2



4 WIRE RTD/RESISTANCE INPUT
Figure 2.3



3 WIRE RTD/RESISTANCE INPUT
Figure 2.4

millivolt input

Connect the millivolt source to the instrument's two center terminals with copper leads, observing polarity. See Figure 2.2.

Select the mV sensor. See Section 2-5.

Read the millivolt input on the display.

RTD input

Attach the RTD leads to the instrument's terminals as follows:

4-wire RTD - Attach the two similarly colored leads to the two positive (left) terminals. Attach the other two leads to the two negative (right) terminals. See Figure 2.3.

Polarity is immaterial. The excitation current flows between the outer positive terminal and the center negative terminal. Voltage is sensed between the two remaining terminals.

3-wire RTD - Attach the two similarly colored leads to the two negative (right) terminals. Attach the third lead to the center positive terminal. See Figure 2.4.

The excitation current flows between the two center terminals. The voltage is sensed between the outer negative terminal and the center positive terminal.

NOTE The two center leads, #1 and #2 in Figure 2.4, should be the same length and gauge.

Configure the instrument for RTD operation by selecting the P (Platinum) sensor. See Section 2.5.

When you press the "Enter" key, the instrument will prompt you to select the 3 or 4 wire option.

Select:	
3 Wire	4 Wire

If you are using a 4 wire RTD, move the cursor to the 4 wire option. If you are using a 3 wire RTD, select the 3 wire option. Press "Enter" to input this selection.

Read the temperature on the display.

ohm input

Connect your leads the same way you did for RTD input

Configure the instrument for ohm operation by selecting Ω from the sensor menu. See Section 2-5. Select 3 wire or 4 wire, as directed in the RTD section.

Read resistance directly in ohms.

output mode

thermocouple output

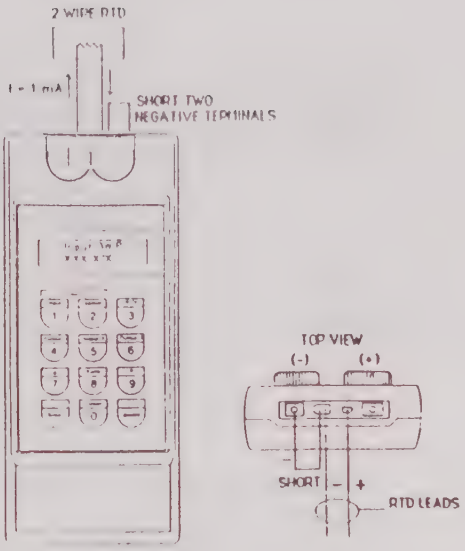
Connect the appropriate thermocouple leads to the two center terminals of the indicator/calibrator and to the instrument to be calibrated, observing polarity. See Figure 2.6.

Set the instrument to the thermocouple type you are simulating. See Section 2-5.

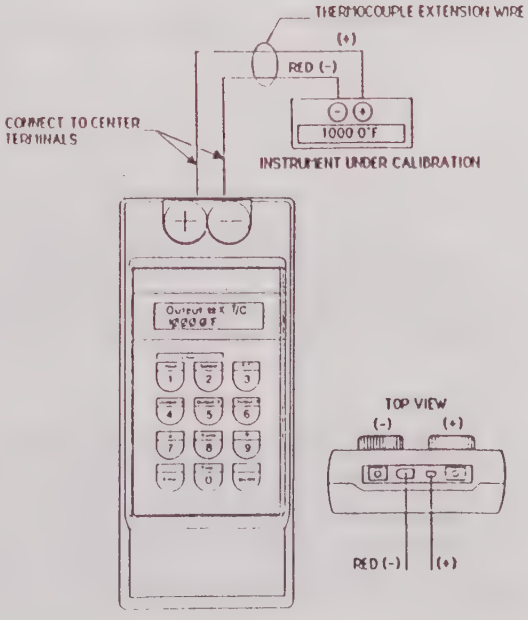
Press one of the output keys, "Output 1, 2 or 3", to enter the output mode. The instrument will now output and display the contents of the selected output memory.

You can change the output's value in 2 ways:

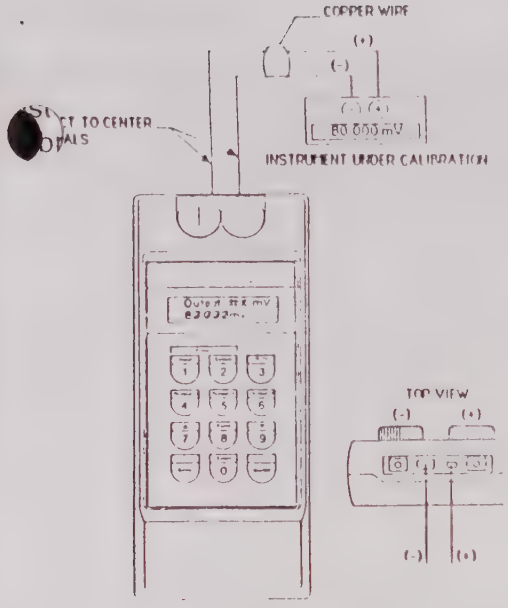
1. Change the output memory values as you did in Section 2-5; or
2. Ramp to a new value. See Section 2-7.



2 WIRE RTD/RESISTANCE INPUT
Figure 2.5



THERMOCOUPLE OUTPUT
Figure 2.6



MILLIVOLT OUTPUT
Figure 2.7

millivolt output

Connect copper leads to the two center terminals of the indicator/calibrator and to the instrument to be calibrated, observing polarity. See Figure 2.7.

Set the indicator/calibrator to millivolts (mV).

Press one of the output keys, "Output 1, 2 or 3", to enter the output mode. The instrument will now output and display the contents of the selected output memory.

You can change the output's value in 2 ways:

1. Change the output memory values as you did in Section 2-5; or
2. Ramp to a new value. See Section 2-7.

RTD output (temperature or ohms)

When simulating RTD's, the output resistance appears across the two center terminals of the indicator/calibrator. The excitation current of the RTD instrument being calibrated must be between 0.1 mA and 2.0 mA. While the indicator/calibrator's RTD output will still function if the current is below 0.1 mA, its accuracy cannot be guaranteed.

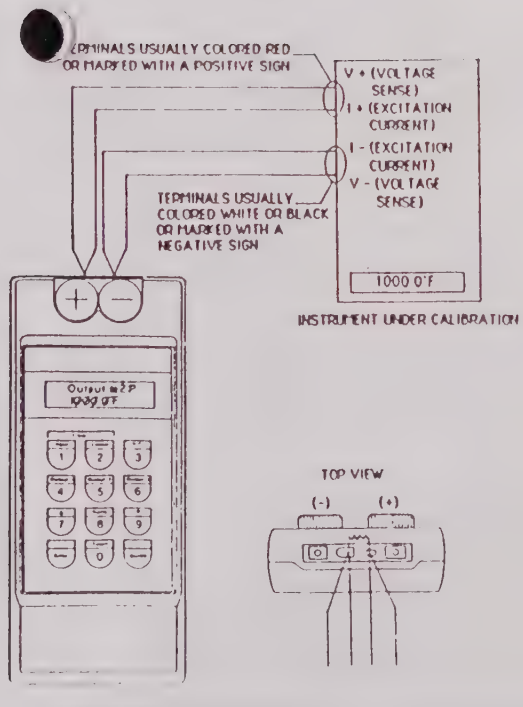
To obtain optimum accuracy, we recommend you first connect the instrument to be calibrated to the indicator/calibrator before outputting the desired value.

Connect the instrument to be calibrated to the indicator/calibrator as follows:

4-wire instruments

Twist the bare ends of two wires together and insert the twisted pair into the center positive terminals of the indicator/calibrator. Connect each of the opposite ends of the two wires to one of the voltage sense terminals and the corresponding excitation current terminal of the instrument being calibrated.

Twist the bare ends of two more wires together and insert the twisted pair into the center negative terminal of the indicator/calibrator. Connect each of the opposite ends of these two wires to the other pair of voltage sense and excitation current terminals of the instrument being calibrated. See figure 2.9.


TERMINALS USUALLY COLORED RED OR MARKED WITH A POSITIVE SIGN
V + (VOLTAGE SENSE)
I + (EXCITATION CURRENT)
I - (EXCITATION CURRENT)
V - (VOLTAGE SENSE)
TERMINALS USUALLY COLORED WHITE OR BLACK OR MARKED WITH A NEGATIVE SIGN
1000.0°F
INSTRUMENT UNDER CALIBRATION
TOP VIEW
(-)
(+)

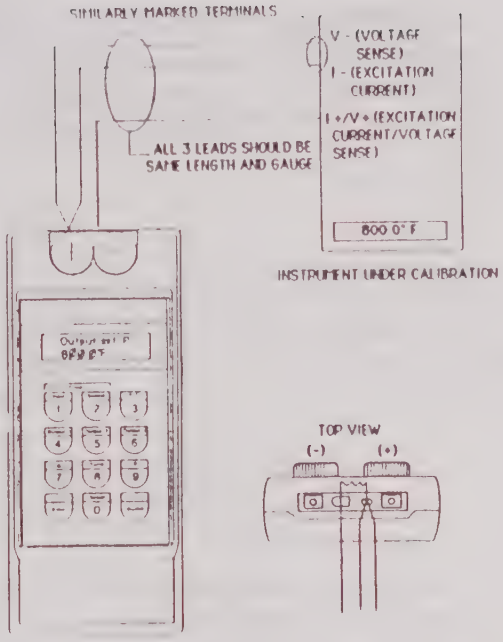
4 WIRE RTD/RESISTANCE OUTPUT USING YOUR OWN LEADS
Figure 2.9

3-wire instruments.

Twist the bare ends of two wires together and insert the twisted pair into the center positive terminal of the indicator/calibrator. Connect one of the opposite ends of the two wires to the voltage sense terminal and the other wire to the corresponding excitation current terminal of the instrument being calibrated.

Insert the third wire into the center negative terminal of the indicator/calibrator and connect the other end of this wire to the third remaining terminal. See Figure 2.11.

NOTE All three of these wires must be the same length and gauge.



3 WIRE RTD/RESISTANCE OUTPUT USING YOUR OWN LEADS
Figure 2.11

2-wire instruments

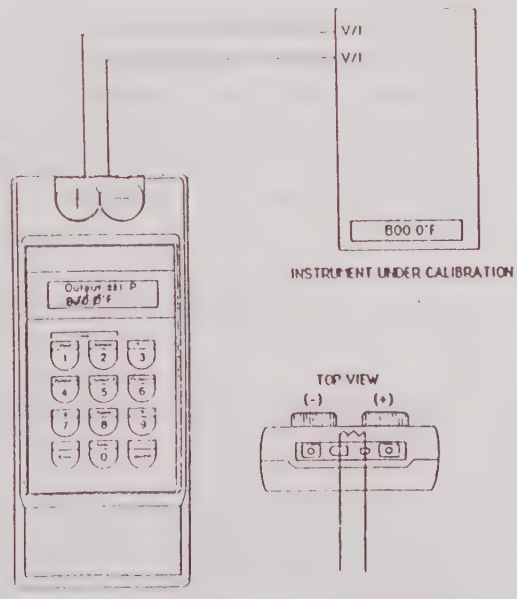
NOTE For 2-wire instruments, lead resistance will cause errors.

Connect one wire to the center positive terminal and the other wire to the center negative terminal of the indicator/calibrator. Connect the opposite ends of these wires to the instrument being calibrated. See Figure 2.12.

After you've completed your connections, configure the indicator/calibrator to either P (for direct temperature output of 100 ohm @ 0° platinum RTD's) or Ω (for outputting RTD's in ohms).

NOTE When outputting RTD's, it does not matter whether the indicator/calibrator is in the 3 or 4-wire mode.

Press one of the output keys, "Output 1, 2 or 3", to enter the output mode. The instrument will now output and display the contents of the selected output memory.



2 WIRE RTD/RESISTANCE OUTPUT
Figure 2.12

You can change the output's value in 2 ways:

1. Change the output memory values as you did in Section 2-5; or
2. Ramp to a new value. See Section 2-7.

NOTE Whenever the RTD output is changed either by pressing an output key or ramping, the display will indicate **WAIT!** The instrument's microprocessor must make many calculations, comparisons and adjustments to achieve its high degree of accuracy for the RTD output.

This takes time. Please be patient. The setting time is no longer than 30 seconds and in most cases, is considerably less. When the **WAIT!** display goes out, the output is fully settled and calibration can be performed.

output ramp

entering ramp mode

Press one of the output keys, "Output 1,2 or 3", to enter the output mode. Press the "Ramp" key. If the instrument is configured for Type J thermocouples and the "Output 1" key is pressed, the display will indicate:

Ramp = 1ØØ.Ø J T/C
Out #1: -346.0°F

This display shows that the instrument is configured for Type J thermocouple, Output #1 is selected, the current contents of Output #1's memory is -346.0°F (Output 1 indicates the lowest temperature, Output 2 indicates the middle temperature and Output 3 indicates the highest temperature of the range selected, unless programmed otherwise) and that the current ramp step is 100.0°C.

Pressing the Λ (up) and ∇ (down) keys will increase or decrease the display by the ramp step. This feature is useful when calibrating or checking instrument alarms and controller proportional band or deadbands. By holding these keys down, the temperature will quickly increase or decrease, by the ramp step, until an **Over range!** or **Under range!** message appears.

As you ramp a selected output memory, you are changing the contents of that memory.

If you want to change the value of the ramp step, please refer to Section 2-5.

If you are outputting resistance (either in temperature or ohms), every time the output is changed the display will indicate **WAIT!** During this time, the instrument's microprocessor is making the calculations, comparisons and adjustments required to achieve its high degree of accuracy.

While the display indicates **WAIT!**, the instrument's output will usually be ≥ 350 Ω (1300°F). If you are checking alarm trip points with this output, we suggest you first set the output above the trip point and then decrease the output toward the trip point. This will guarantee that the alarm will trip only when the output settles at the displayed value.

exiting ramp mode

There are 2 ways to exit the ramp mode:

1. Pressing the "Ramp" key will take you out of the ramp mode and return you to the regular output mode. You will then be outputting the same value as you were in the ramp mode.

NOTE When you leave the ramp mode and reenter the normal output mode, pressing the Δ (up) or ∇ (down) keys will increase or decrease the display by the least significant digit, rather than the ramp step. This will also change the selected output's memory contents.

2. Pressing the "Input" key will return the instrument to the input mode. The sensor type and other configuration parameters will remain the same.

exiting output mode

You may exit the output mode and return to the input mode at any time by pressing the "Input" key.

Section 3 maintenance

3-1 general maintenance

Under the terms of the warranty (discussed fully in Section 4 of this manual), the instrument is warranted to be free from all defects in material and workmanship for a period of two years...and the manufacturer's liability is limited to the repair or replacement of the product only if failure occurs during the warranty period ***and factory inspection shows no external effects or customer repair altered the functioning of the instrument.***

As the indicator/calibrator is a complex and sophisticated electronic instrument and you risk voiding your warranty under the terms described above, any repair or replacement of parts should be attempted only by technically qualified individuals.

While recalibration of the instrument ***can*** be done in the field if you have the following equipment and trained personnel, we recommend you return the instrument to us for recalibration or any other service that may be required.

equipment required for recalibration

- Adjustable mV standard, 0 to 99.000 mV, 0.0001 mV resolution, with an accuracy of ±0.0005 mV
- Low EMF and low resistance shorting terminal (gold or copper) or 0.0000 mV standard, with an accuracy of ± 0.0005 mV
- 400.000 Ω resistance standard, with an accuracy of ± 0.005 Ω
- Stirred ice bath (32.00°F), with an accuracy of ± 0.05°F
- ISA J precision reference thermocouple with a known error at a temperature differential between room temperature and ice (32.0°F), with an accuracy of ± 0.1°F (± 0.003 mV). This reference thermocouple is available from Thermo Electric.

3-2 troubleshooting guide

The following is a basic troubleshooting guide which can be used to help identify and correct problems that may occur with the instrument.

If you are unable to perform these checks or they do not correct the problem, you can call a Service Representative at the factory, who may be able to help you resolve the problem over the phone.

If the problem still cannot be resolved, the instrument should be returned to the factory for repair. If this is necessary, please follow these instructions:

1. Pack the instrument carefully, to prevent shipping damage.

2. Include a brief note with a description of the problem and your company's name, address, phone number, your name and any other identifying data required to contact you and return the instrument.

Symptom	Possible Cause	Corrective Action
Input indication is incorrect	Thermocouple or copper wires may be connected backwards or incorrectly.	Refer to Section 2-6.
	Instrument may be in output mode instead of input mode.	Return instrument to input mode. Refer to Section 2-7.
	Instrument is set for wrong sensor type.	Refer to Section 2-5.
	Thermocouple is defective.	Verify correct instrument operation by placing it in any thermocouple range, except Type B. Short the input. If the instrument is working properly, it should indicate room temperature.
	Poor thermocouple placement.	Verify thermocouple placement at measuring point.
Incorrect output	Thermocouple or copper lead wires may be connected backwards or incorrectly.	See Section 2-7.
	Instrument is set for wrong sensor type.	Refer to Section 2-5.
	Instrument is in input instead of output mode.	Enter output mode. Refer to Section 2-7.
	Possible broken leads or connecting wire.	Check leads or use known working leads.
	"+" and/or "-" knobs may not be fully tightened.	Tighten knobs. Do not overtighten.
Input indication jumps when in input mode or output signal jumps when in output mode.	Input/output wires and/or instrument may be placed too close to EMI/RFI source (e.g. a large inductor or large RF transmitter).	Place input/output wires and/or instrument some distance from interference source to prevent noise pick-up.
		Shield input/output wires.
	If in output mode, output may not yet be settled.	Allow time for settling. Refer to specs in Section 5.
	"+" and/or "-" knobs may not be fully tightened.	Tighten knobs. Do not overtightened.
	If using adapter, may be using wrong adapter or line voltage may be too low or occasionally dipping	Make sure AC adapter is specified for your line voltage. Try using line conditioner or operate instrument on batteries
		If problem persists, return instrument for service.

Section 4 warranty

Manufacturer warrants each of its instruments to be free from defects in material and workmanship for a period of two years, commencing on the date of shipment.

The liability of the seller is limited to the repair and replacement of the product only if failure occurs during the warranty period and factory inspection shows no external effects or customer repair altered the functioning of the instrument.

The instrument is to be returned to the factory, freight prepaid, via the most economical surface transporta tion method, after authorization. All charges for handling, reinstalling and miscellaneous expenses incurred will be the responsibility of the buyer.

When factory examination shows the returned instru ment to be within the above warranty period, the equipment will be repaired or replaced, at the seller's option, at no charge to the buyer.

This warranty shall be rendered null and void when, in the judgement of qualified factory personnel, the equipment has been subjected to abnormal or abusive use or lack of proper care or maintenance by the buyer, or when it has been determined that environmental conditions have exceeded those specified by the manufacturer.

Any alteration or repair of the instrument by the buyer or any party not authorized by the factory without our specific consent, in writing, shall automatically terminate our warranty obligation.

This warranty on instruments manufactured and/or sold by us or any service provided by us, is expressly in lieu of all other warranties expressed or implied. No warranty is made of merchantability or fitness for any particular purpose.

No agent is authorized to assume any liability for it or to make any written or oral warranties or obligations beyond those set forth herein, unless endorsed, in writing, and signed by an officer of the manufacturer.

Section 5 specifications

ambient operating temperature	0° to 55°C (32° to 131 °F)
storage temperature (without batteries)	-20° to 70°C (-4° to 158°F)
warm up time (time required to meet full specifications)	15 minutes under normal ambient conditions
normal mode rejection	>50 db @ 60 Hz
common mode rejection	>125 db with AC adapter @ 230 VRMS, 60 Hz
temperature stability	15 ppm of reading/degree (max)
input/output resolution	
thermocouples	0.1°
millivolts	0.001 mV
RTD's	0.1°
ohms	0.01Ω
input impedance	100 MΩ
input leakage current	< 10 nA
input error due to source resistance	1 μV/100Ω
output impedance	≤ 0.005 ohms; output into a fixed load
output drive capability	45Ω fixed load (min) @ 100 mV output (max) 35Ω fixed load (min) @ 80 mV output (max) 15Ω fixed load (min) @ 40 mV output (max) 10Ω fixed load (min) @ 25 mV output (max)
Output settling time	
thermocouples	settles to within 0.5°F in <3 seconds
millivolts	settles to within 0.008 millivolts in <3 seconds
RTD's	settles to final value in <30 seconds
ohms	settles to final value in <30 seconds
thermocouple output compensation	fully compensated for changes in ambient temperature
maximum RTD output excitation current	2mA
maximum RTD lead resistance	
4 wire	300Ω
3 wire	150Ω
RTD input excitation current	1 mA
RJC error @ 25°C	± 0.1°F (max)
RJC compensation error	
J, K, T, E, N, Platinel II	0.02 deg/deg* (max)
R, S, B, W5/W26	0.05 deg/deg* (max)
	*deg/deg = $\frac{\text{T deg error}}{\Delta T_{amb}\text{deg}}$
power	6 disposable AA batteries or AC adapter, 115 or 230 VAC, 50/60 Hz
power consumption (AC)	0.5 Watts (max)
battery life (alkaline batteries)	
continuous use	50 hours (min) @ 75°F
normal use	>70 hours @ 75°F
shelf life	>6 months @ 75°F
case material	polycarbonate (G.E. Lexan™, Grade 141)
cover material	polypropylene
membrane keypad material	polycarbonate
weight (with batteries)	28 ounces

external dimensions	
length	8.6"
width	3.75"
depth	2.38"
display	2 lines of 16 alphanumeric characters, 5 x 7 matrix LCD
display update rate	2 updates/second
calibration uncertainty	
(instrument trace-ability to NIST)	
thermocouples:	
J, K, T, E, N, Platinel II	± 0.25°F (max)
R, S, B, W5/W26	± 1.2°F (max)
millivolts	± 0.0035 mV (max)
RTD's	±0.1°F (max)
ohms	±0.015Ω (max)
long term calibration stability	
thermocouples:	
J, K, T, E, N, Platinel II	± 0.1°F/month (max)
R, S, B, W5/W26	± 0.3°F/month (max)
millivolts	± 0.001 mV/month (max)
RTD's	±0.1°F/month (max)
ohms	±0.01Ω/month (max)
recommended calibration interval (period over which instrument will meet stated accuracy)	6 months

ISA Calibration	Available Range	Resolution	Accuracy Range(s)	Typical Accuracy 32°F (0°C) to 90% of span	Overall Accuracy
J [2]	-346.0 to 2192.0°F	0.1°F	-346.0 to 2192.0°F	±0.1°F	±0.5°F
	-210.0 to 1200.0°C	0.1°C	-210.0 to 1200.0°C	±0.05°C	±0.3°C
K [2]	-382.0 to 2500.0°F	0.1°F	-382.0 to -310.0°F	N.A.	±1.0°F
			-310.0 to 2500.0°F	±0.1°F	±0.5°F
	-194.4 to 1371.1°C	0.1°C	-194.4 to -190.0°C	N.A.	±0.6°C
			-190.0 to 1371.1°C	±0.05°C	±0.3°C
T [2]	-340.0 to 752.0°F	0.1°F	-340.0 to 752.0°F	±0.1°F	±0.5°F
	-206.7 to 400.0°C	0.1°C	-206.7 to 400.0°C	±0.05°C	±0.3°C
E [2]	-320.0 to 1832.0°F	0.1°F	-320.0 to 1832.0°F	±0.1°F	±0.5°F
	-195.6 to 1000.0°C	0.1°C	-195.6 to 1000.0°C	±0.05°C	±0.3°C
N [3]	32.0 to 2372.0°F	0.1°F	32.0 to 2372.0°F	±0.1°F	±0.5°F
	0.0 to 1300.0°C	0.1°C	0.0 to 1300.0°C	±0.05°C	±0.3°C
W5/W26 [4]	32.0 to 4200.0°F	0.1°F	32.0 to 4200.0°F	±0.3°F	±0.7°F
	0.0 to 2315.6°C	0.1°C	0.0 to 2315.6°C	±0.2°C	±0.4°C
Platinel II [5]	-140.0 to 2543.0°F	0.1°F	-140.0 to 2543.0°F	±0.1°F	±0.5°F
	- 95.5 to 1395.0°C	0.1°C	- 95.5 to 1395.0°C	±0.05°C	±0.3°C
R [2]	0.0 to 3200.0°F	0.1°F	0.0 to 32.0°F	N.A.	±2.5°F
			32.0 to 3200.0°F	±0.8°F	±1.7°F
	-17.8 to 1760.0°C	0.1°C	-17.8 to 0.0°C	N.A.	±1.4°C
			0.0° to 1760.0°C	±0.5°C	±0.9°C
S [2]	0.0 to 3200.0°F	0.1°F	0.0 to 32.0°F	N.A.	±2.5°F
			32.0 to 3200.0°F	±0.8°F	±1.7°F
	-17.8 to 1760.0°C	0.1°C	-17.8 to 0.0°C	N.A.	±1.4°C
			0.0° to 1760.0°C	±0.5°C	±0.9°C
B [2]	1000.0 to 3300.0°F	0.1°F	1000.0 to 3300.0°F	±0.8°F	±1.7°F
	537.8 to 1815.6°C	0.1°C	537.8 to 1815.6°C	±0.5°C	±0.9°C
RTD in [6]	-320.0 to 1500.0°F	0.1°F	-320.0 to 1500.0°F	±0.1°F	±0.5°F
	-195.5 to 815.6°C	0.1°C	-195.5 to 815.6°C	±0.05°C	±0.3°C
RTD out [6,7]	-320.0 to 1500.0°F	0.1°F	-320.0 to 1500.0°F	±0.2°F	±0.7°F
	-195.5 to 815.6°C	0.1°C	-195.5 to 815.6°C	±0.1°C	±0.4°C
		(typical error @ 1ex = 1.0 mA)			
Ohms in	0.00 to 700.00Ω	0.01Ω	0.00 to 700.00Ω	±0.01Ω	±0.05Ω
Ohms out [7]	0.00 to 400.00Ω	0.01Ω	0.00 to 400.00Ω	±0.02Ω	±0.14Ω
		(typical error @ 1ex = 1.0 mA)			
mV	-9.999 to 99.999mV	0.001mV	-9.999 to 99.999mV	±0.001mV	±0.005mV

1 At 75°F ±5°F within 6 months after calibration
2 Conformity based on IPTS-68: NBS Monograph 125
3 Conformity based on NBS Monograph 161 (AWG 14)
4 Conformity based on Hoskins Manufacturing Co., W5/W26 T/C
5 Conformity based on Engelhard Platinel II T/C
6 100 Ohm @0°C platinum RTD having an Alpha of 0.00385 with its conformity based on the DIN 4376 standard
7 With an excitation current between 0.1 mA and 2.0 mA

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